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(71) Applicant(s)
Decorule Limited
(Incorporated in the United Kingdom)
The Paddock, 182 Main Road, Milford, STAFFORD, ST17 0UN, United Kingdom

(72) Inventor(s)
Frank Moeller

(74) Agent and/or Address for Service
Forrester Ketley & Co
Chamberlain House, Paradise Place, BIRMINGHAM, B3 3HP, United Kingdom

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H2A AKX2 AK117 AK120 AK211 AK217R AK803 AK808
U1S S1820

(56) Documents Cited
GB 2114218 A **GB 2085963 A** **GB 0172114 A**
EP 0779422 A **EP 0666634 A** **US 4485768 A**

(58) Field of Search
UK CL (Edition P) **F1B B1B6**
INT CL[6] **F02B 75/24**
Online: WPI

(54) Abstract Title
A hybrid engine for a vehicle with a balanced flat I.C. engine and a generator with rotating permanent magnets

(57) A hybrid engine 10 for propelling a vehicle comprises a balanced, preferably twin cylinder, flat internal combustion engine 11 whose crankshaft 19 is coupled to a generator 12 that has rotating permanent magnets 35. The internal combustion engine 11 comprises a first and a second piston 13, 14 drivingly connected to the crankshaft 19 via a first and a second connecting rod 16, 18 respectively. The first piston 13 and the second piston 14 are disposed on opposite sides of the crankshaft 19 so that the longitudinal axis of the pistons 13, 14 are aligned, i.e. they are coaxial, to reduce out of balance forces. One of the connecting rods 16 may comprises a first and a second limb 16a, 16b connected to the crankshaft 19 by a first and a second big end bearing 20a, 20b respectively while the second connecting rod 18 may be connected to the crankshaft 19 by a third big end bearing disposed between the first and second bearings 20a, 20b.

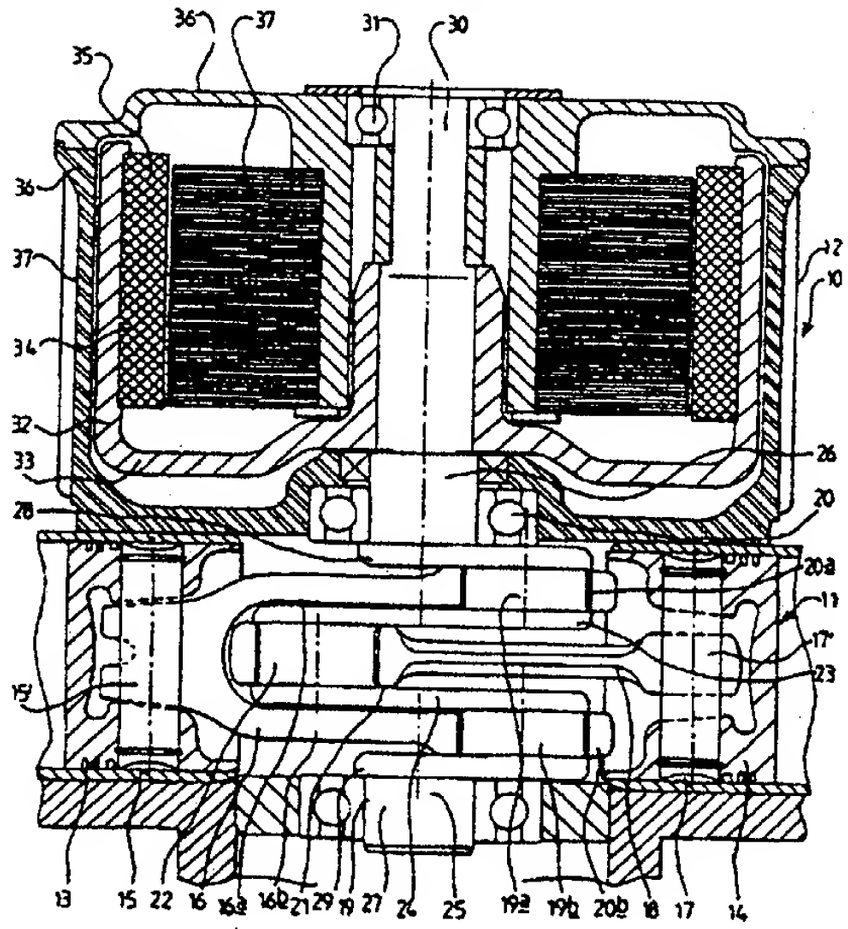

FIG 1

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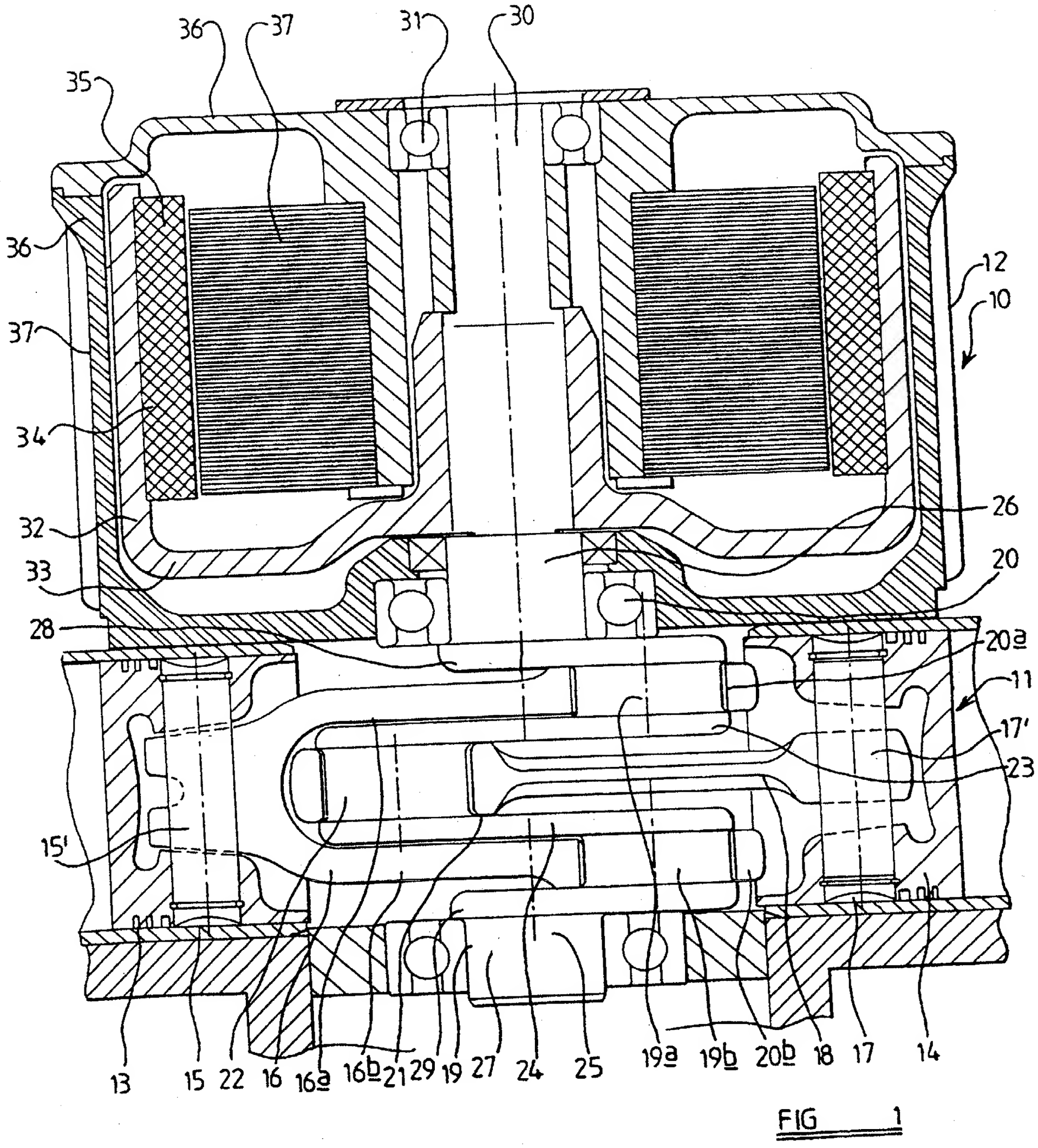

FIG 1

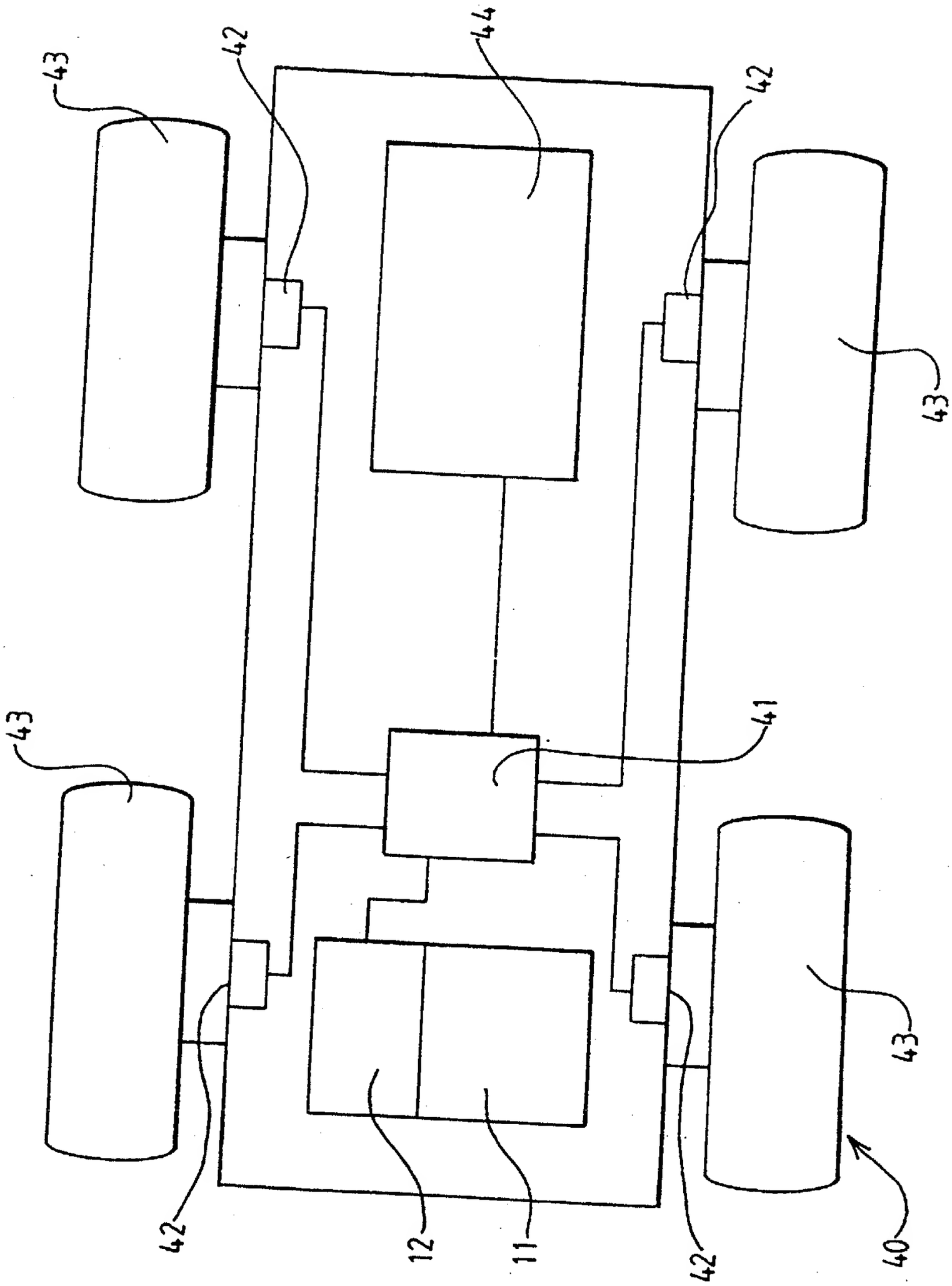

FIG 2

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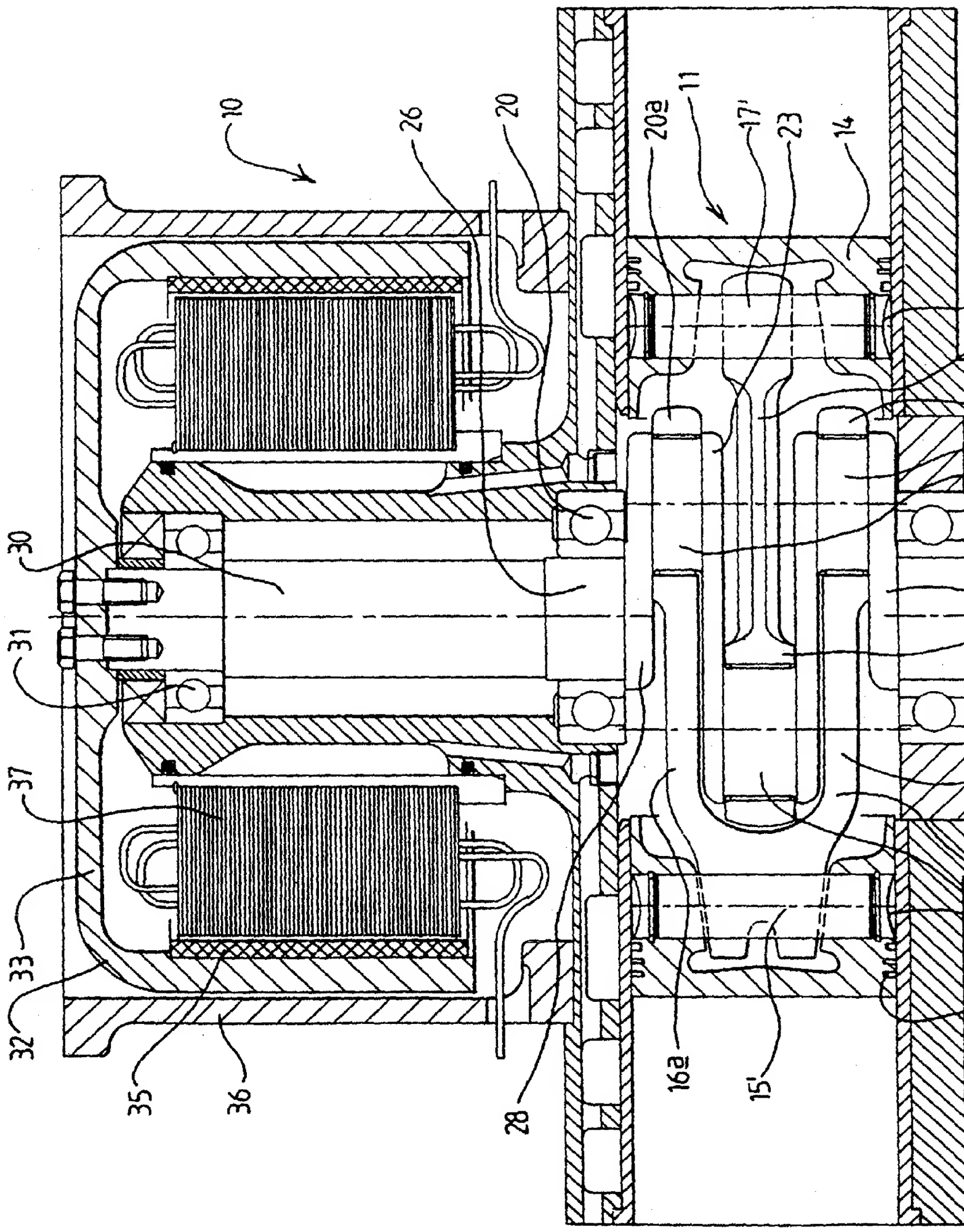
10
26
20
20a
11
17'
23
14
17
18
19b
20b
25
19a
30
31
29
27
21
37
19
16b
22
16
33
15
32
13
35
36
28
16a
15'

FIG 3

Title: Reciprocatory Engine

Description of Invention

This invention relates to reciprocatory engines, and particularly but not exclusively for an arrangement in which a reciprocatory engine is operable in combination with an electric generator, such an arrangement being referred to herein as a hybrid engine.

It is known to produce a relatively efficient engine by combining a reciprocatory engine, in particular an internal combustion engine, with a generator for use in a vehicle driven by electric motors. Since the motive power of the vehicle is provided only by the electric motors, the internal combustion engine can be run at a constant speed which is optimised for its most efficient performance. The internal combustion engine drives the generator which supplies power either to an electric motor to drive the vehicle or to batteries which can then be called on to supply the electric motor. Such a hybrid engine will require a smaller internal combustion engine than a comparably sized vehicle driven only by an internal combustion engine, but internal combustion engines with smaller combustion chambers are less efficient, and for internal combustion engines with smaller numbers of cylinders, vibration and noise problems are apparent.

An aim of the invention is to reduce or overcome the above mentioned problems.

According to a first aspect of the present invention we provide a reciprocatory engine comprising a first piston and a second piston, each reciprocable in a cylinder, the first piston being drivably connected by a first connecting rod to a crank shaft and the second piston being drivingly connected by a second connecting rod to the crank shaft wherein the first piston and the second piston are disposed on opposite sides of the crank shaft and wherein the

longitudinal axis of each piston is aligned such that out of balance forces in the engine are eliminated or reduced.

The first connecting rod may comprise a first limb and a second limb, the first limb and the second limb being connected to the crank shaft by a first big end bearing and a second big end bearing respectively which are spaced apart.

The limbs may be generally parallel and disposed equidistant from the longitudinal axis of the connecting rod.

The second connecting rod may be connected to the crank shaft by a third big end bearing disposed between the first big end bearing and the second big end bearing.

The connecting rods may be of equal weight and the centre of gravity of each connecting rod may be disposed at the same distance from the end of each connecting rod on the longitudinal axis of each connecting rod.

The first connecting rod may comprise a first material and the second connecting rod may comprise a second material, the first material having a lower density than the second material.

According to a second aspect of the present invention we provide a hybrid engine comprising a reciprocatory engine according to the first aspect of the invention and a generator having a generator shaft wherein the crank shaft is drivingly connected to the generator shaft.

According to a third aspect of the invention we provide a hybrid engine comprising a reciprocatory engine and a generator having a generator shaft, the reciprocatory engine having a crank shaft which is drivingly connected to the generator shaft.

In the second or third aspects of the invention, the generator may comprise permanent magnets and generator windings, the permanent magnets being rotatable relative to the generator windings.

The permanent magnets may be drivingly connected to the generator shaft.

Alternatively, or in addition, the generator output power may be supplied to an electric motor.

Generator output power may be supplied to a storage means, for example a battery.

The generator output power may be in the range 1 to 50 kilowatts and is preferably is around 15 kilowatts.

In any aspect of the invention, the reciprocatory engine may comprise an internal combustion engine.

The internal combustion engine may be a petrol engine, or a diesel engine.

The operating speed of the reciprocatory engine may be in the range 3000 to 30000 rpm and is preferably around 8000 rpm.

The invention will now be described by way of reference only with reference to the accompanying drawings wherein:

FIGURE 1 is a cross-section through a hybrid engine according to the invention,

FIGURE 2 is a schematic illustration of a vehicle having a hybrid engine according to the invention, and

FIGURE 3is a cross section through another example of a hybrid engine embodying the invention which may be used in the vehicle of Figure 2.

As shown in the Figures, a hybrid engine is shown generally at 10 and comprises an internal combustion engine 11 and a generator 12. The internal combustion engine 11 comprises a first piston 13 and a second piston 14, each reciprocable in a cylinder 13a, 14a respectively. The piston 13 is connected by a first gudgeon pin 15 to a first connecting rod 16, while the second piston 14 is connected via a second gudgeon pin 17 to a second connecting rod 18. The first connecting rod 16 is bifurcated and comprises two limbs, 16a, 16b which are spaced apart, generally parallel and are disposed equidistant from the longitudinal axis of the connecting rod. However, if desired, the limbs may be asymmetrically

disposed relative to the longitudinal axis of the connecting rod. A section 15', 18' of each gudgeon pin 15, 18 respectively is journalled in an eye provided in the connecting rod 16, 18 respectively.

The internal combustion engine 11 further comprises a crank shaft 19 which is journalled at its one end 26 in a bearing 20 and at its other end 27 in further bearing 27a.

At the end of each limb 16a, 16b of the first connecting rod 16 is an eye 20a, 20b in which a section 19a, 19b respectively of the crank shaft 19 is journalled, providing a first big end bearing and a second big end bearing respectively. Similarly, the connecting rod 18 comprises an eye 21 in which a section 22 of the crank shaft is journalled, providing a third big end bearing, which is disposed between the first and second big end bearings. The section of the crank shaft 22 is disposed between the sections 19a, 19b and is connected thereto by crank webs 23, 24. The crank shaft sections 19a, 19b are connected to the end sections 26, 27 of the crank shaft 19 by further crank shaft webs 28, 29.

The connecting rods 16 and 18 have the same mass, and their respective centres of gravity are disposed at an equal distance along their respective longitudinal axes. For this to be achieved, the connecting rod 16 must comprise a material having a density lower than the material used in connecting rod 18. If the connecting rods are of a different shape to that of the present example they may be shaped to be of the same mass and have centres of gravity disposed at equal distances from one end of the connecting rod along the respective longitudinal axis even when each is made of material of the same density.

The internal combustion engine 11 may comprise a two stroke or a four stroke engine, preferably a four stroke engine and may comprise any number of cylinders as desired, preferably two, providing that the engine remains balanced over the whole of the firing cycle. For example, such a balance may be achieved for a four cylinder engine provided with two connecting rods each having two

limbs, similar to the first connecting described hereinbefore and two single limb connecting rods, similar to the connecting rod 18 described hereinbefore.

The generator comprises a generator shaft 30 directly connected to the crank shaft 19. A free end of the generator shaft 30 is journalled in a bearing 31. A cradle 32 is connected to the generator shaft 30 and comprises a first part 33 extending transversely to the generator shaft and a second part 34 connected to the transverse part 33 and disposed generally parallel to the crank shaft 30. Mounted on the second part 34 is a ferrite magnet 35. Mounted on the case 36 of the generator 12 is a set of windings 37 disposed between the ferrite magnet 35 and the generator shaft 30. A rectifier may be provided as necessary in the output of the generator.

A vehicle 40 comprising a hybrid motor 10 is shown in Figure 2. The current from the generator is directed by a controller 41 to one or more electric motors 42. Here one motor 42 at each wheel 43 is shown, although a single motor driving two or more wheels, or two motors each driving one or more wheels, or any other combination could be envisaged. The controller can also direct current to batteries 44.

In operation, the internal combustion engine 11 is run constantly at a high speed, optimised to run at its maximum efficiency. The pistons 13, 14 are synchronised. Thus as shown in the Figure, both pistons 13, 14 are at the "bottom" part of their stroke just prior to moving to the left and right respectively as seen in Figure 1. The pistons 13, 14 turn the crankshaft 19 driving the generator shaft 30. The current generated by the generator 12 is directed by the controller to the motors 42 driving the wheels 43. When the demand for current is in excess of that provided by the generator 12, the batteries 44 can supply the additional current. Similarly any excess generated current can be used to charge the storage batteries 44.

Although the generator shaft 30 is shown as being directly connected to the crankshaft 19 by virtue of being integral therewith, a direct or an indirect connection, for example via a gearbox or clutch means may be provided.

In Figure 3 another example of a hybrid engine is illustrated and the same reference numerals have been used in Figure 3 as were used with reference to Figure 1 to refer to corresponding parts. The description with reference to Figure 1 is applicable, mutatis mutandis, to the engine of Figure 3.

Although the reciprocatory engines disclosed herein have been shown in combination with a generator, it will be appreciated that such an engine can be used in combination with any other suitable apparatus or for any other purpose as desired, in particular in applications where a reduced level of engine vibration is required.

The features disclosed in the foregoing description, or the accompanying drawings, expressed in their specific forms or in terms of a means for performing the disclosed function, or a method or process for attaining the disclosed result, or a class or group of substances or compositions, as appropriate, may, separately or in any combination of such features, be utilised for realising the invention in diverse forms thereof.

CLAIMS

1. A reciprocatory engine comprising a first piston and a second piston, each reciprocal in a cylinder, the first piston being drivably connected by a first connecting rod to a crank shaft and the second piston being drivingly connected by a second connecting rod to the crank shaft wherein the first piston and the second piston are disposed on opposite sides of the crank shaft and wherein the longitudinal axis of each piston is aligned such that out of balance forces in the engine are eliminated or reduced.

2. A reciprocatory engine according to Claim 1 wherein the first connecting rod comprises a first limb and a second limb, the first limb and the second limb being connected to the crank shaft by a first big end bearing and a second big end bearing respectively which are spaced apart.

3. A reciprocatory engine according to Claim 2 wherein the limbs are generally parallel and disposed equidistant from the longitudinal axis of the connecting rod.

4. A reciprocatory engine according to Claim 2 or Claim 3 wherein the second connecting rod is connected to the crank shaft by a third big end bearing disposed between the first big end bearing and the second big end bearing.

5. A reciprocatory engine according to any one of Claims 2 to 4 wherein the connecting rods are of equal weight and the centre of gravity of each connecting rod is disposed at the same distance from the end of each connecting rod on the longitudinal axis of each connecting rod.

6. A reciprocatory engine according to Claim 5 wherein the first connecting rod comprises a first material and the second connecting rod comprises a second material, the first material having a lower density that the second material.

7. A hybrid engine comprising a reciprocatory engine according to any one of the preceding Claims and a generator having a generator shaft wherein the crank shaft is drivingly connected to the generator shaft.

8. A hybrid engine comprising a reciprocatory engine and a generator having a generator shaft, the reciprocatory engine having a crank shaft which is drivingly connected to the generator shaft.

9. A hybrid engine according to Claim 7 or Claim 8 wherein the generator comprises permanent magnets and generator windings, the permanent magnets being rotatable relative to the generator windings.

10. A hybrid engine according to Claim 9 wherein the permanent magnets are drivingly connected to the generator shaft.

11. A hybrid engine according to any one of claims 7 to 10 wherein the generator output power is supplied to an electric motor.

12. A hybrid engine according to any one of claims 7 to 11 wherein the generator output power is supplied to a storage means.

13. A hybrid engine according to any one of Claims 7 to 12 wherein the generator output power is in the range 1 to 50 kilowatts and is preferably is around 15 kilowatts.

14. A reciprocatory engine or a hybrid engine according to any one of the preceding Claims wherein the reciprocatory engine comprises an internal combustion engine.

15. A reciprocatory engine or hybrid engine according to Claim 14 wherein the internal combustion engine comprises a petrol engine.

16. A reciprocatory engine or hybrid engine according to Claim 14 wherein the internal combustion engine comprises a diesel engine.

17. A hybrid engine according to any one of Claims 7 to 16 wherein the operating speed of the reciprocatory engine is in the range 3000 to 30000 rpm and is preferably around 8000 rpm.

18. A reciprocatory engine substantially as hereinbefore described with reference to the accompanying drawings.

19. A hybrid engine substantially as hereinbefore described with reference to the accompanying drawings.

20. A vehicle comprising a hybrid engine according to any one of Claims 7 to 17 or Claim 14.

21. A vehicle comprising a reciprocatory engine according to any one of Claims 1 to 6 or Claim 19.

22. Any novel feature or novel combination of features described herein and/or in the accompanying drawings.

The Patent Office

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Application No: GB 9817970.8 **Examiner:** David Glover
Claims searched: 1-7, 9-21 **Date of search:** 14 October 1998

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.P): F1B (B1B6)

Int Cl (Ed.6): F02B 75/24

Other: Online: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X Y	GB 2114218 A	(Green) see figures 1-3	X: 1, 14 - 16, 21 Y: 7, 9-13, 20
X Y	GB 2085963 A	(Faulkner) see figure 1	X: 1, 14 - 16, 21 Y: 7, 9-13, 20
X Y	GB 0172114	(Smith) see figure and note connection of rod to crank pin	X: 1-4, 14-16, 21 Y: 7, 9-13, 20
A	EP 0779422 A1	(Piccinini) see figure 2 note tie pin 22	1-4
Y	EP 0666634 A1	(Fichtel & Sachs) see figure and note direct drive generator for an I.C. engine	7, 9-13, 20
Y	US 3994354	(Haumaier) see figure and note constant speed I.C. engine and electric generator	7, 11-13, 20

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

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Claims searched: 1-7, 9-21 **Date of search:** 14 October 1998

Category	Identity of document and relevant passage	Relevant to claims

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
		E	Patent document published on or after, but with priority date earlier than, the filing date of this application.
&	Member of the same patent family		

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